U.S. Department of Energy's

Office of Science

National Academy of Sciences

Fusion Energy Sciences Program

Board on Physics and Astronomy

National Academy of Sciences

Excellent Science
Attractive Energy

Office of Fusion Energy Sciences

www.ofes.fusion.doe.gov

Dr. N. Anne Davies
Associate Director
for Fusion Energy Sciences

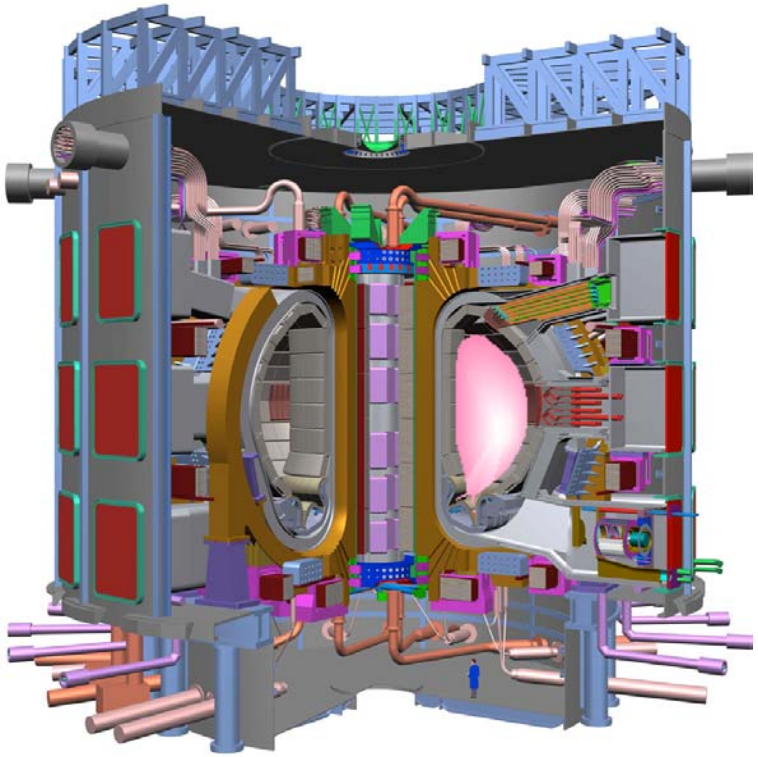
April 25, 2003

ITER

Based on:

- FESAC Report on Burning Plasma Physics
- FESAC Letter on 35-year schedule for fusion power
- NRC Interim Report on Burning Plasma Physics

The President has decided.



DOE NEWS
U.S. DEPARTMENT OF ENERGY • OFFICE OF PUBLIC AFFAIRS • WASHINGTON, DC 20585

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FOR IMMEDIATE RELEASE
Thursday, January 30, 2003

… MEDIA UPDATE …

The following is a statement by President Bush about ITER, a major international fusion project. Energy Secretary Abraham announced the President's decision that the U.S. will participate in the project in remarks today at the Department of Energy's Princeton Plasma Physics Laboratory. Secretary Abraham's prepared remarks are available at **www.energy.gov**

The White House
Office of the Press Secretary

For Immediate Release January 30, 2003

STATEMENT BY THE PRESIDENT

I am pleased to announce that the United States will join ITER, an ambitious international research project to harness the promise of fusion energy. The results of ITER will advance the effort to produce clean, safe, renewable, and commercially-available fusion energy by the middle of this century. Commercialization of fusion has the potential to dramatically improve America's energy security while significantly reducing air pollution and emissions of greenhouse gases.

The United States will be working with the United Kingdom, other European Union nations, Russia, China, Japan and Canada on the creation of ITER. Today, I am directing the Secretary of Energy to represent the United States at the upcoming ITER meetings in St. Petersburg, Russia. We welcome the opportunity to work with our partners to make fusion energy a reality.

###

Status of "Negotiations"

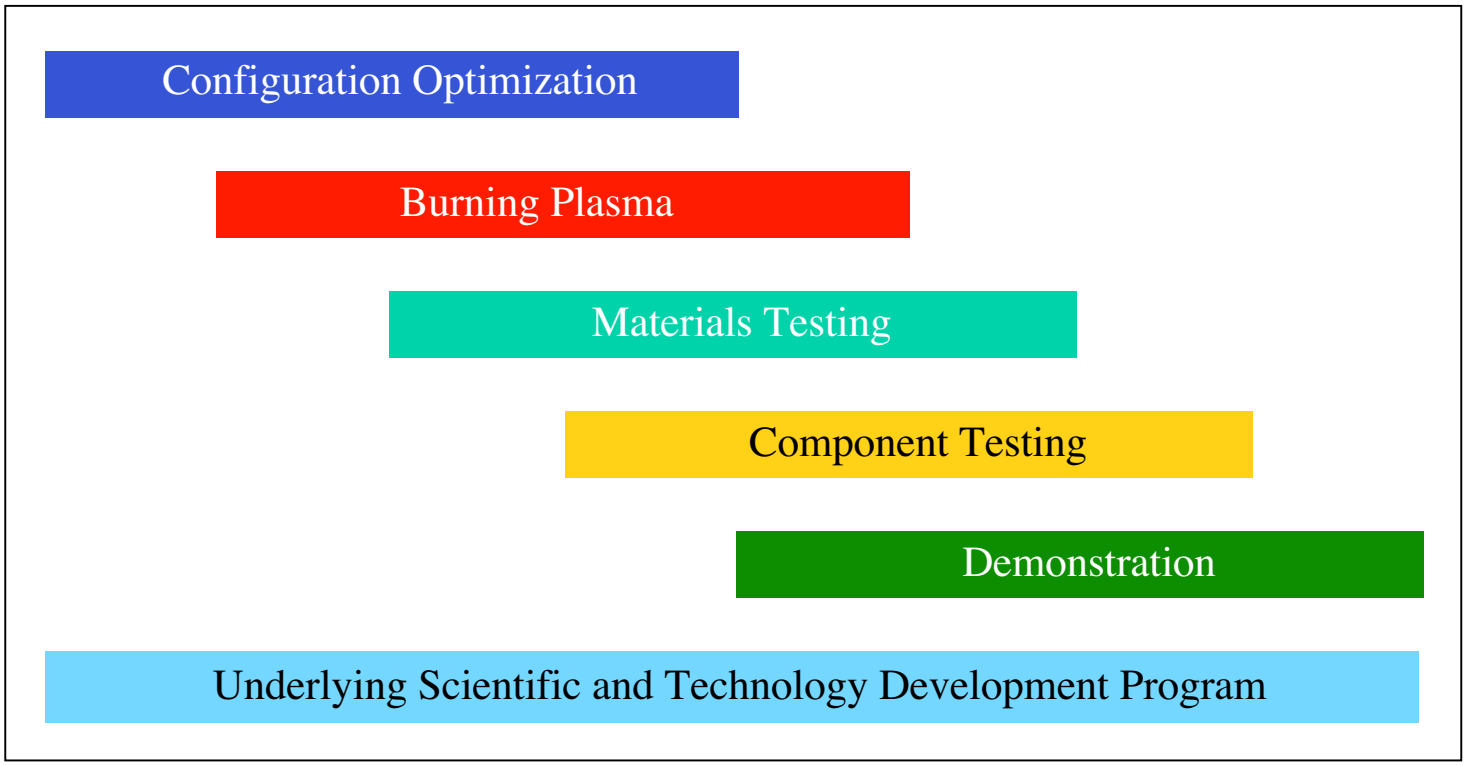
(actually, Exploratory Discussions)

- Advanced
  - Principally Governmental Issues
    - Intellectual Property Rights
    - Non Proliferation concerns
    - Privileges and Immunities
    - Site assessment –now completed: www.iter.org/jass
- Beginning
  - Principally Programmatic Issues
    - Procurement processes
    - Component allocations
    - Management approaches/tools

Next Steps

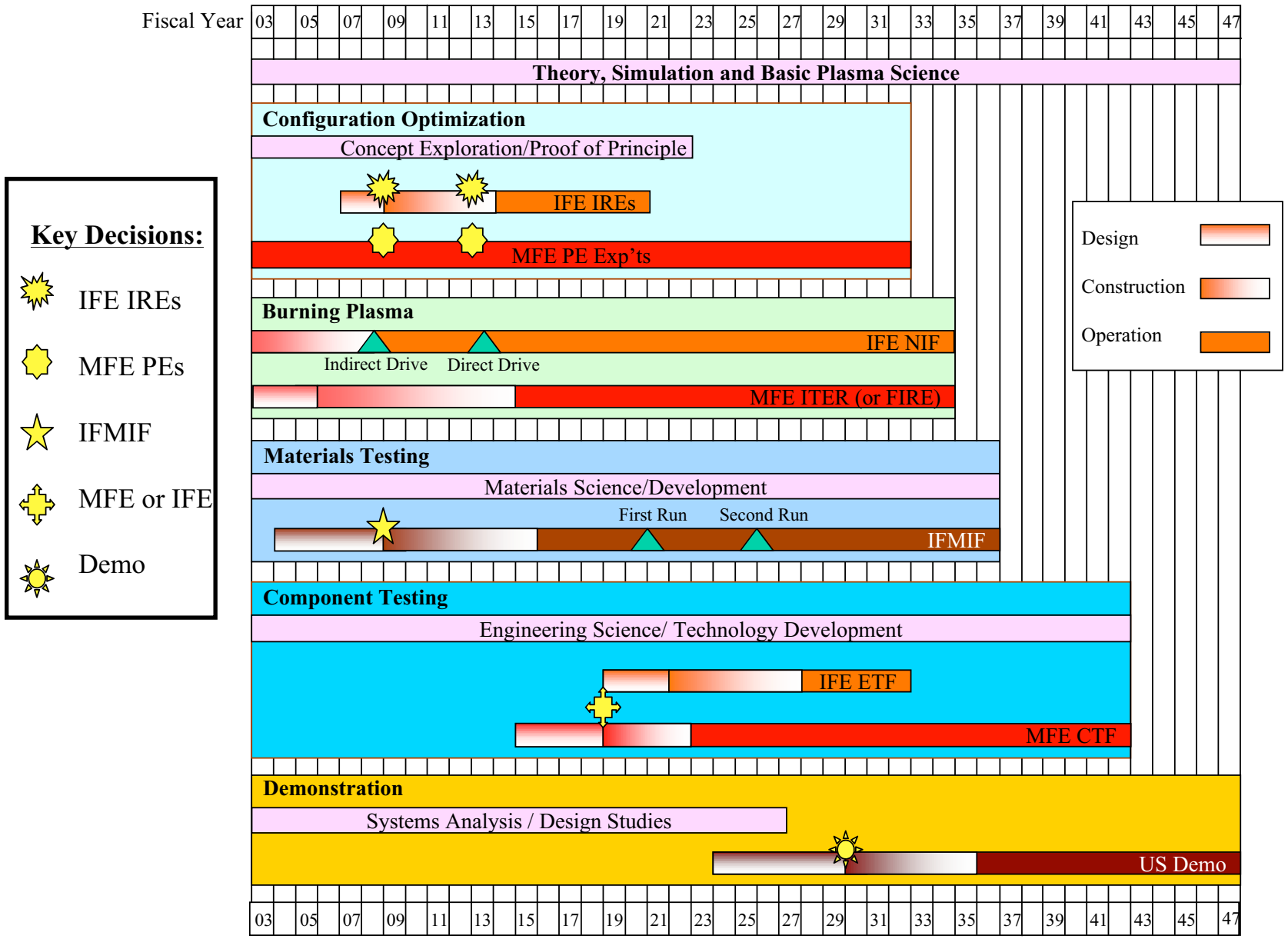
- Toronto (April 8-17)
  - Clarington Site Visit
  - Process Discussion on Decision-Making — Tokyo (late April/early May)
  - Topical Meetings — Garching (May)
    - IPR principles
    - Management/Staffing
    - Procurement Issues
    - Decommissioning
  - Working Group
  - Addressing draft text
- Garching (May 19-22) — Totonto (?) (June)
  - Preparatory Committee
  - Exploratory Discussions
  - First Substantive Negotiations
- New York (September)
  - UN General Assembly (possible consensus among ITER Parties' senior officials on advancing ITER)

A Plan for the Development of Fusion Energy
FESAC 3/03



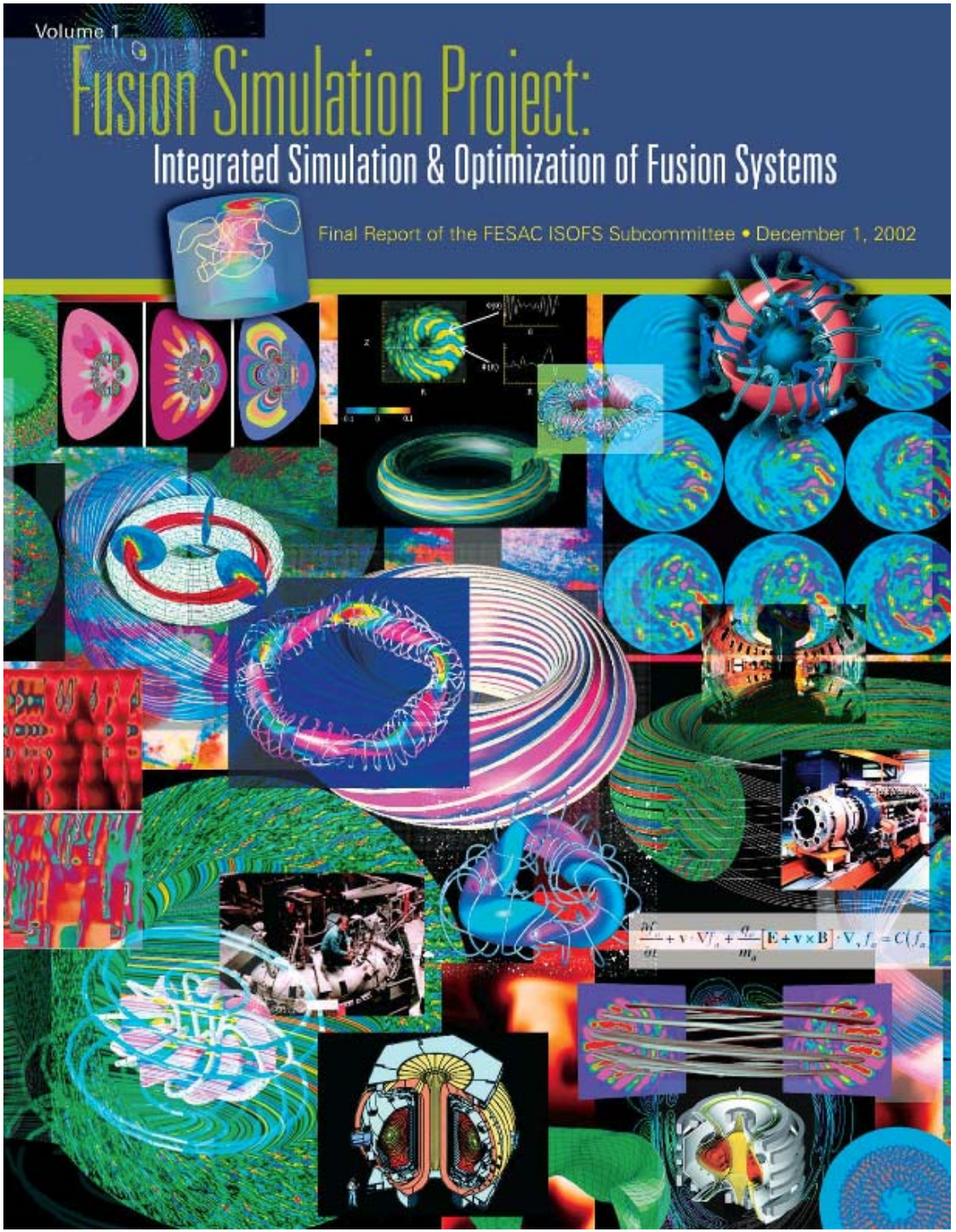
Overlapping scientific and technological challenges define the sequence of major facilities needed in the fusion development path. Programs in theory and simulation, basic plasma science, concept exploration and proof of principle experimentation, materials development and plasma, fusion chamber and power technologies from the foundation for research on the major facilities.

The Fusion Energy Sciences Advisory Committee has Developed a Plan for Commercial Fusion by Mid-Century



Fusion Simulation Project

FESAC 12/02



Ongoing NRC Review

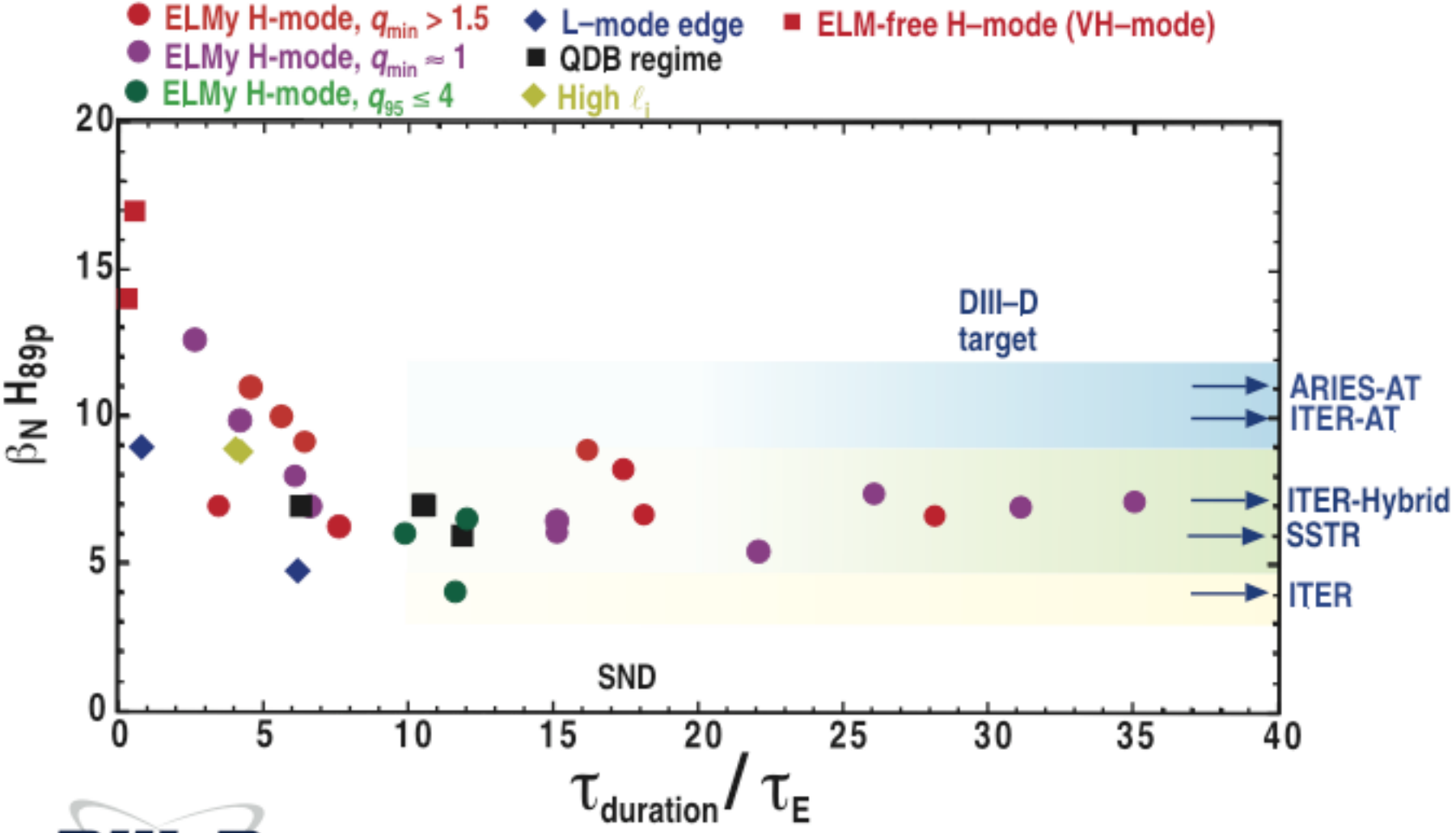
Looking forward to

final report from

Burning Plasma Assessment Committee

SIGNIFICANT PROGRESS TOWARD LONG-PULSE HIGH PERFORMANCE

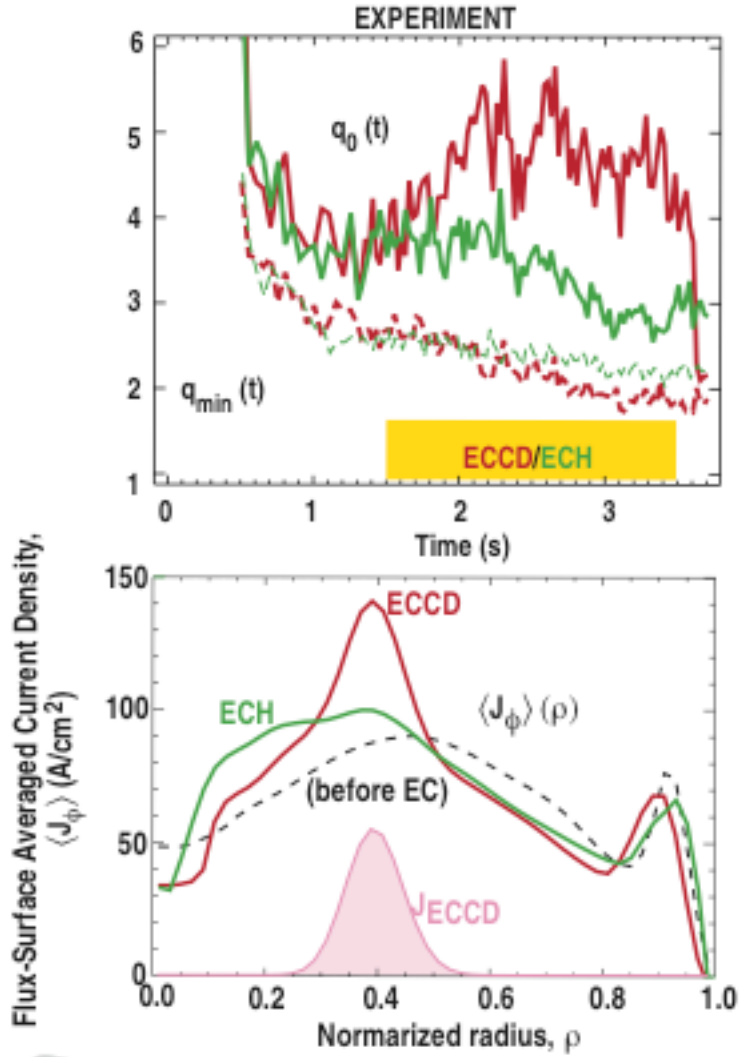
- Advanced performance found in many operating regimes



DIII–D NATIONAL FUSION FACILITY

CLEAR DEMONSTRATION OF CURRENT PROFILE MODIFICATION BY ECCD IN HIGH PERFORMANCE PLASMAS

- $\beta_N = 2.8 \sim \beta_N^{\text{no wall}}$



High Bootstrap Fraction AT

I_p	1.2 MA		B_T	1.85 T
ECCD	0.13 MA	10%	EC	2.5 MW
NBCD		30%	NB	8 MW
Bootstrap		53%	β_T	3.1%
Ohmic		7%	β_N	2.8
Non-Inductive		93%	H	2.5
			$\beta_N H$	7

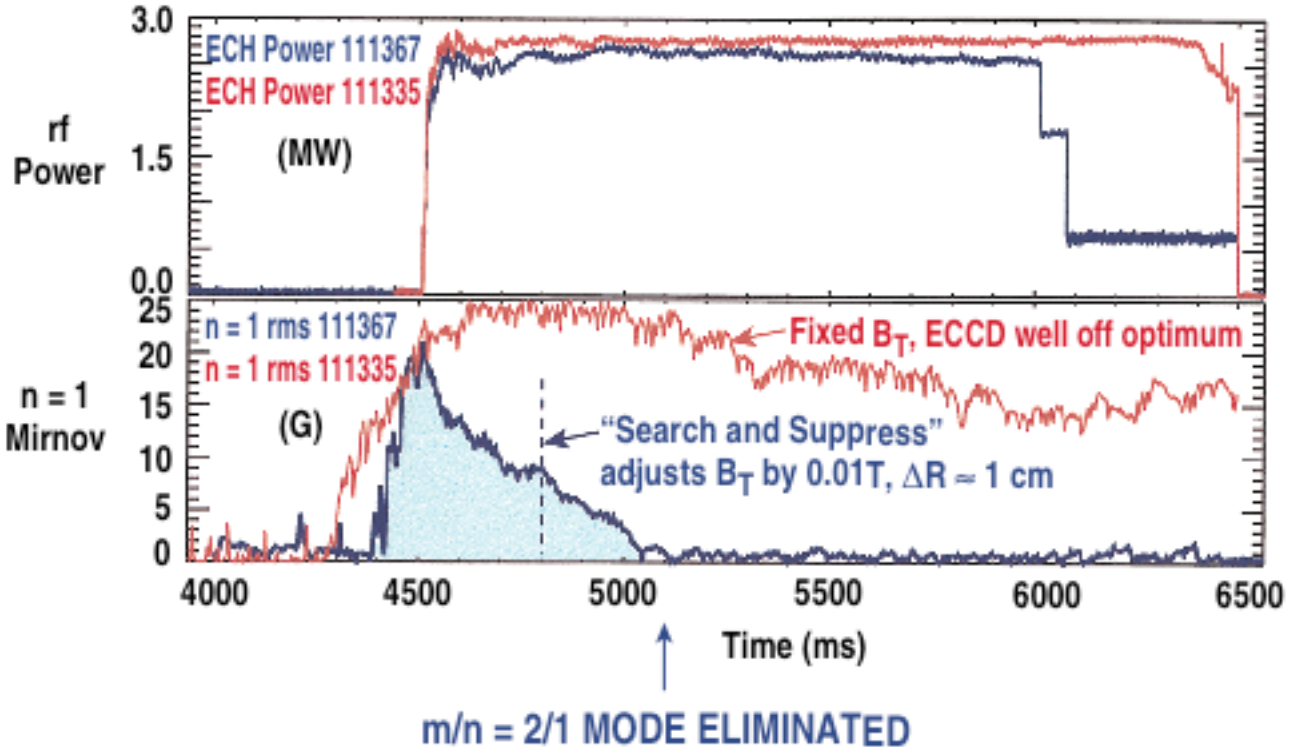
Tools needed to raise beta for long pulse

- RWM stabilization
  - — high triangularity pumped DND
- 6 MW EC system → 9 MW
- 3 MW FW system → 6 MW
- Upgraded transformer for heating systems

DIII-D NATIONAL FUSION FACILITY SAN DIEGO

FEEDBACK STABILIZATION OF NTMs WITH LOCALIZED ECCD WORKS

- m/n = 3/2, 2/1, NTM completely stabilized with ECCD



- Future work
  - optimize feedback algorithms
  - increase beta

    ⇒ Increased ECCD pulse length and power

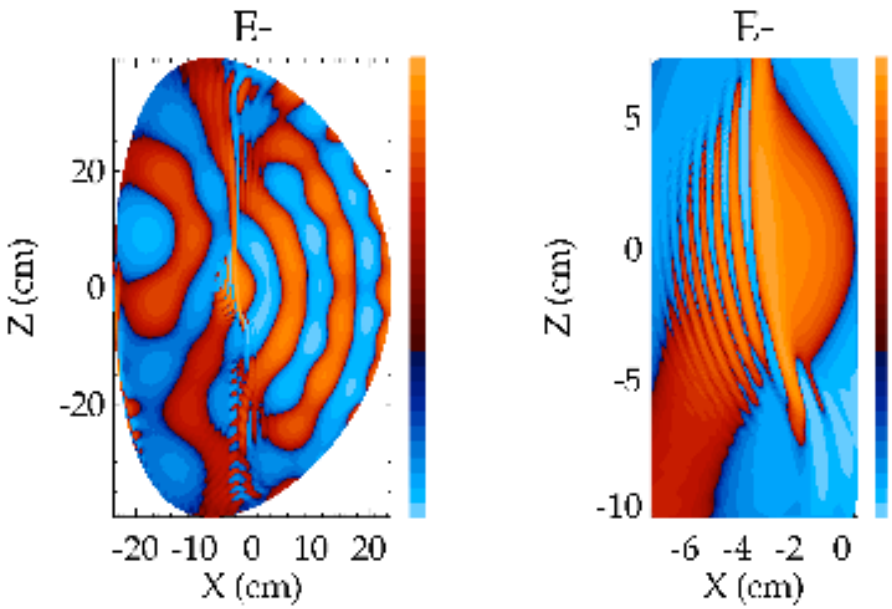
DIII-D NATIONAL FUSION FACILITY SAN DIEGO

ICRF Physics and Technology

Alcator C-Mod

ICRF Physics

There is fascinating and important physics in RF, e.g. mode conversion (to ICW).



Partnership with Computer modeling.

Innovative diagnostics of waves.

RF Technology

We need to turn this from an art into a science if it is to be reliable for a Burning Plasma Experiment.

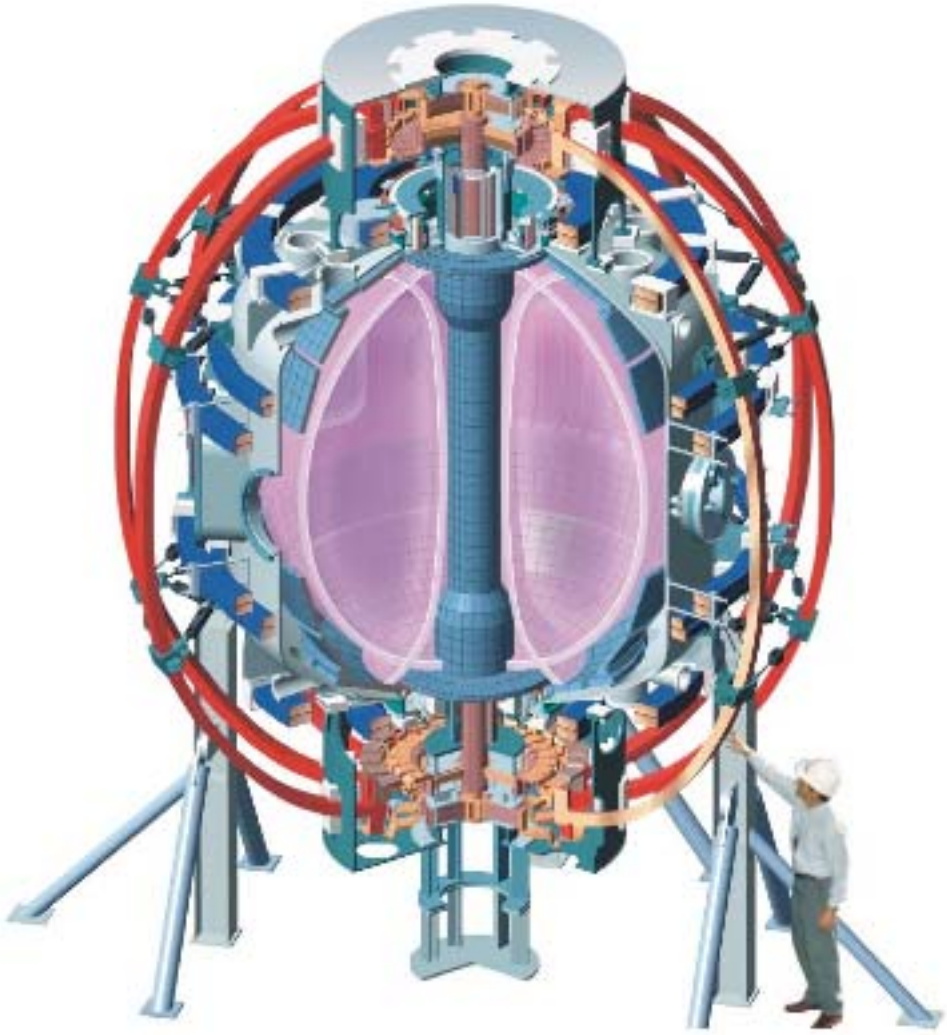
The tokamak environment is unique in having high B, copious radiation and ionization sources, disruptive eddy forces. Experiments have to be done in situ.

Studies of science of voltage limits and antenna-plasma interactions.

Major initiative in load-tolerant matching circuits.

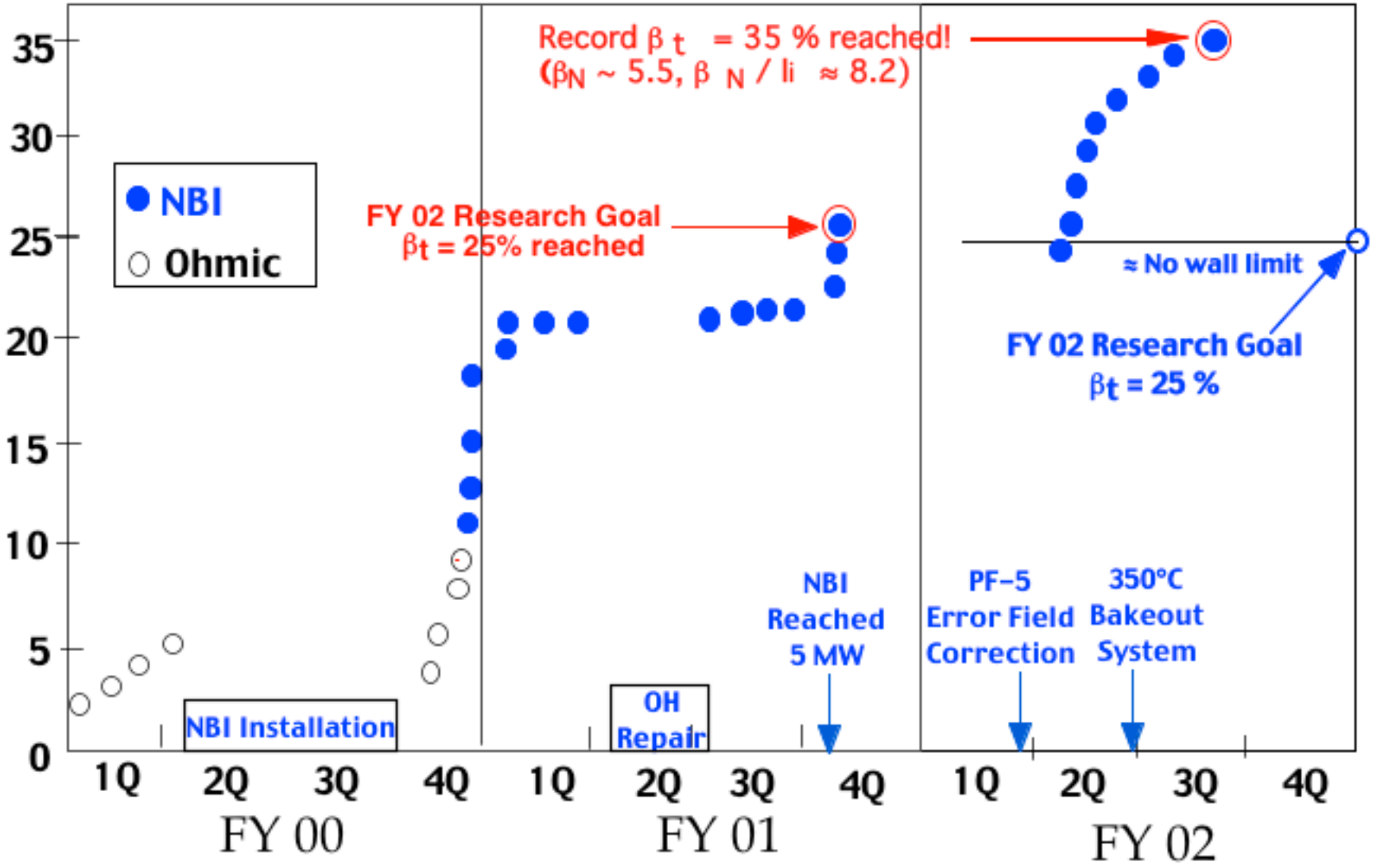
Want on-site technologist participation.

NSTX Facility Capability Steadily Improved

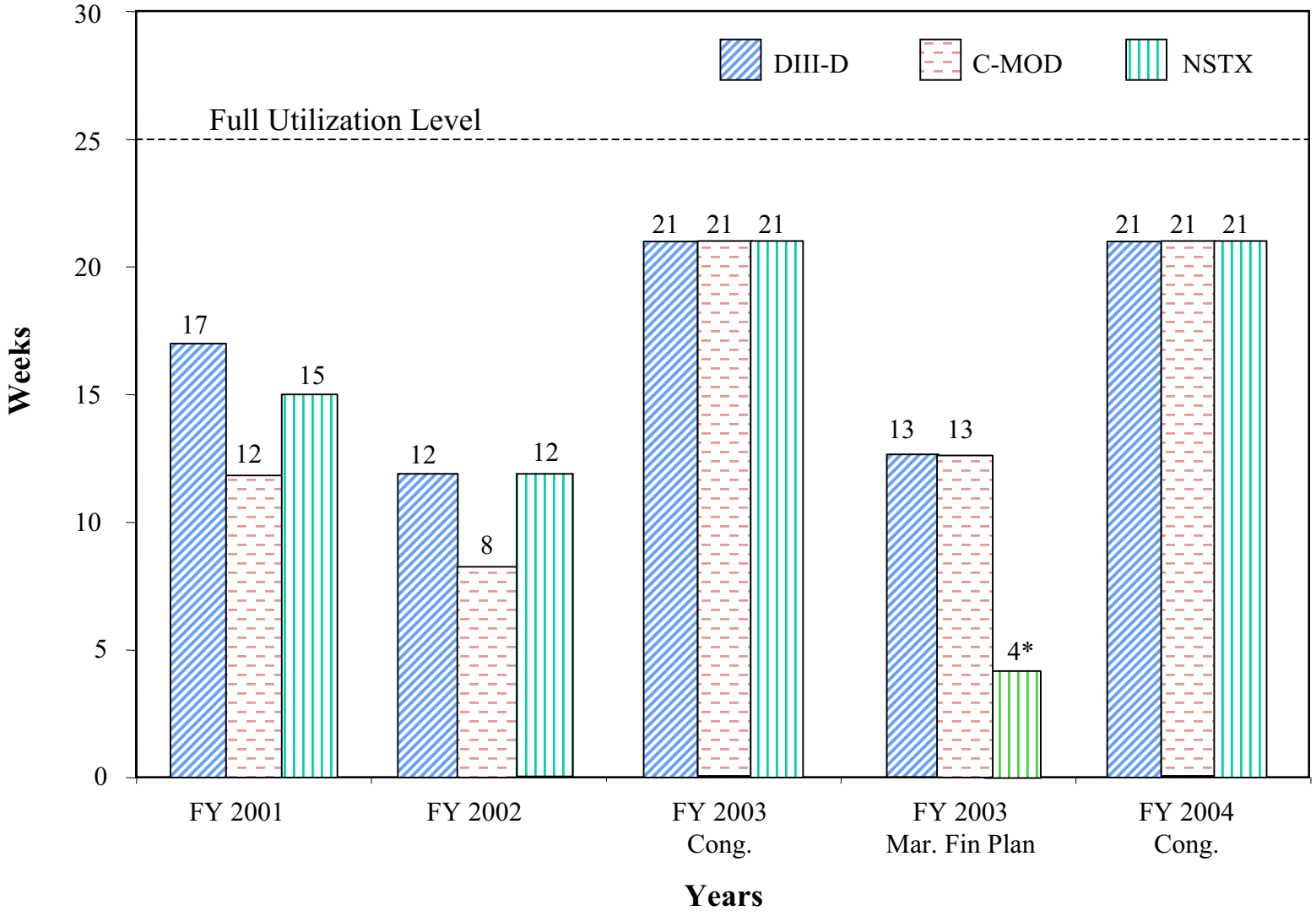


Capabilities	
PFC bakeout	***350°C***
Gas fueling	***HFS/LFS***
Aspect ratio	1.27
Elongation	2.5
Triangularity	***0.8***
Plasma Current	1.5MA
Toroidal Field	***0.6T***
NBI ***(100kV)***	***7 MW***
HHFW (30MHz)	6 MW
- full antenna phase control	
Pulse Length	***1s***
Reduced PF error field	

Rapid Progress On High Beta Research



Major Fusion Facilities Operating Times

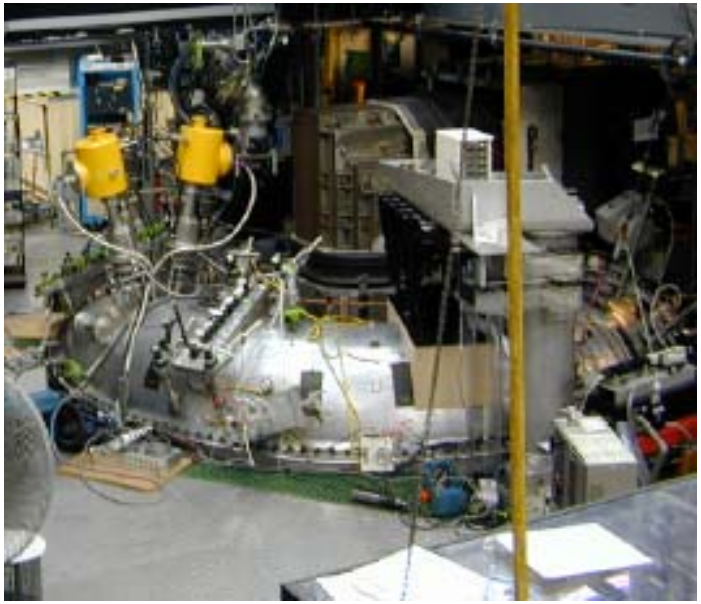


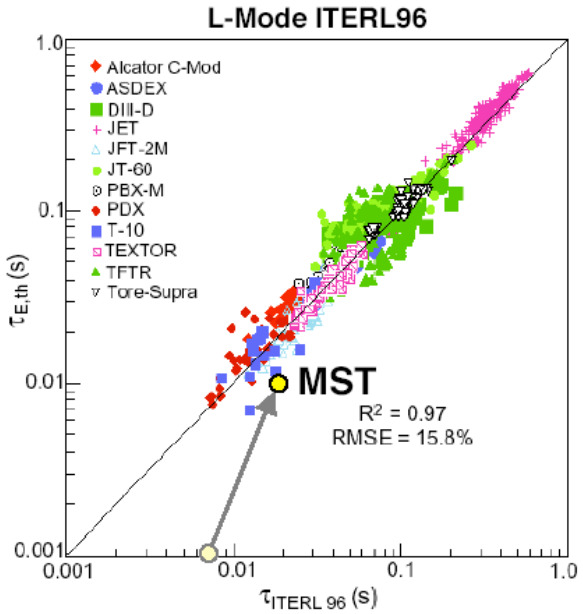
*NSTX operating time is reduced due to the failure of one of the magnetic coils in February. The coil will be repaired during the March-September timeframe.

03/03/03

Madison Symmetric Torus (MST)

- Goals:
  - Advance the Reversed Field Pinch (RFP) fusion concept
  - Understand magnetic self organization: cause and consequence of magnetic fluctuations
  - Obtain high confinement, high beta, and high temperature simultaneously in a non-transient plasma





Achievements and Status:

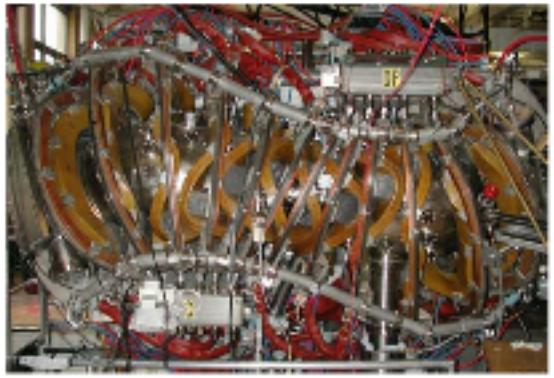
Thermal diffusivity: $\chi_e \sim 5\ m^2/s$

Confinement time: $\tau_e \sim 10$ ms

(Confinement quality comparable to tokamak has been attained in 2002)

$T_e \sim 1.3$ keV

US Compact Stellarator *Program*

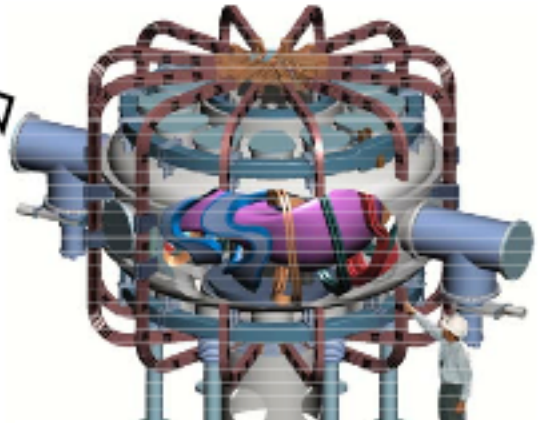


HSX, University of Wisconsin

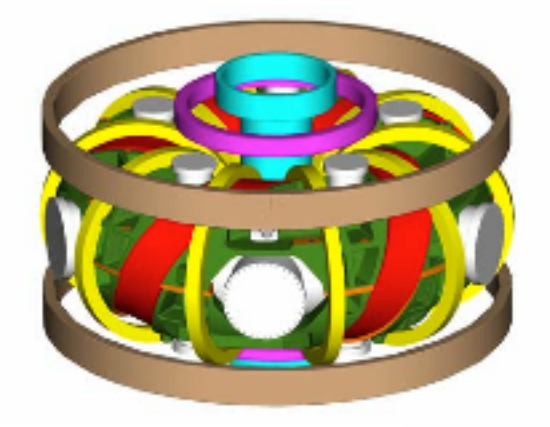
Theory and Modeling

3-D Plasma Science
Improved Understanding
of Toroidal Confinement
Benefits of 3-D Shaping

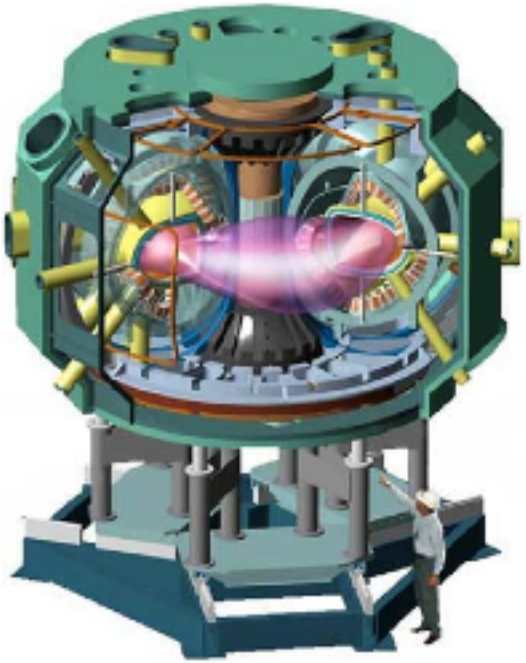
Improvements
in Toroidal
Fusion Reactor
Systems



QPS, Oak Ridge National Lab

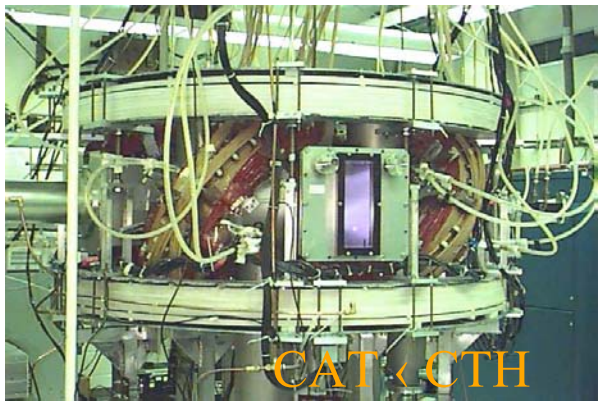


CTH, Auburn University



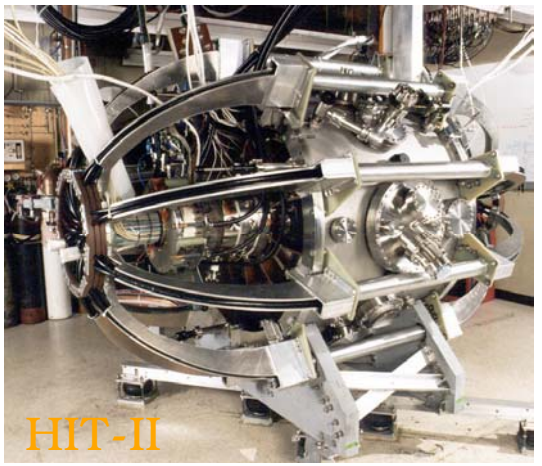
NCSX, Princeton Plasma Physics Lab

Innovative Confinement Concepts



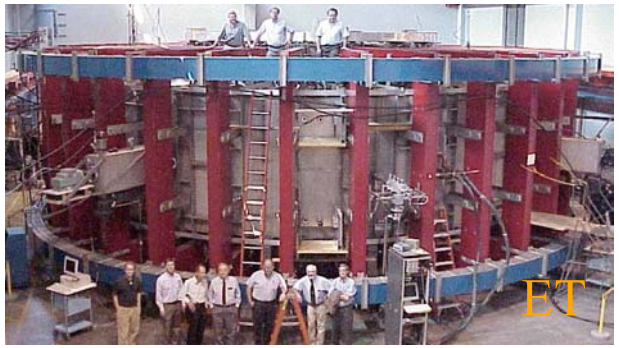
Compact Auburn Torsatron becoming
Compact Toroidal Hybrid
Auburn University, Auburn Alabama

Levitated Dipole Experiment
Columbia University/Massachusetts
Institute of Technology

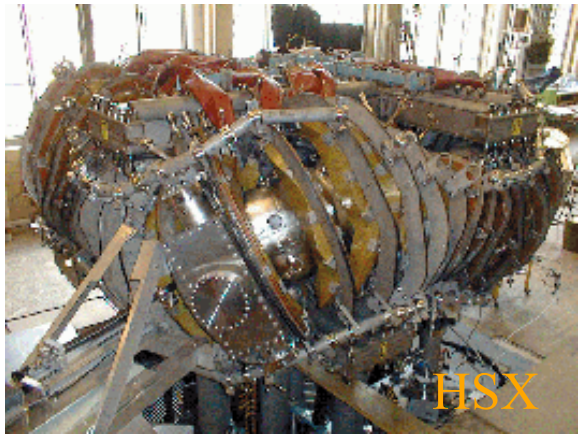


Helicity Injected Torus-II Experiment
University of Washington, Seattle

Sustained Spheromak
Plasma Experiment
Lawrence Livermore National Laboratory



Electric Tokamak
University of California, Los Angeles



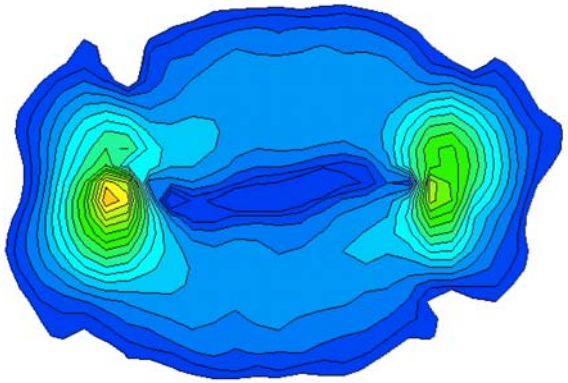
Helically Symmetric Experiment
University of Wisconsin, Madison

Scientific Discovery Thru Advanced Computing

Three Principal Projects

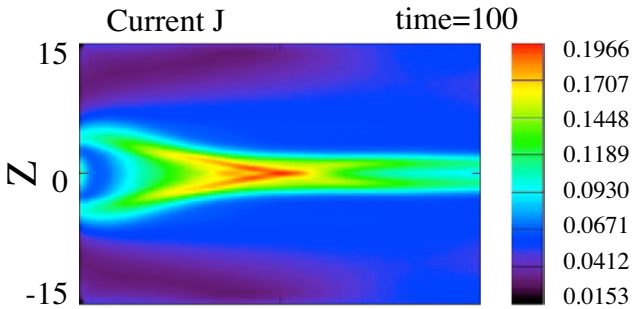
Terascale Atomic Physics

Auburn, Rollins, ORNL



Magnetic Reconnection Code

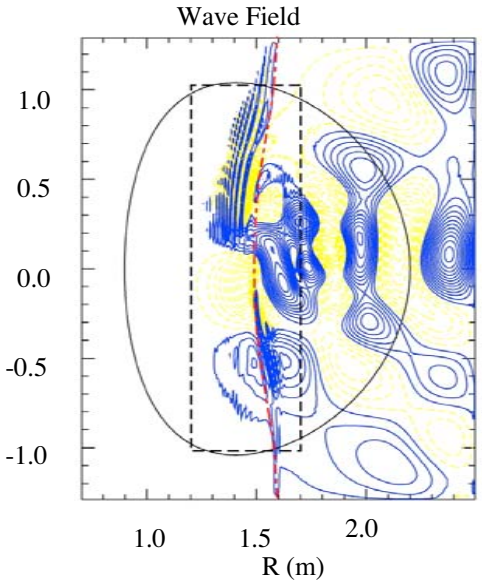
U. Iowa, U. Chicago, U. Texas



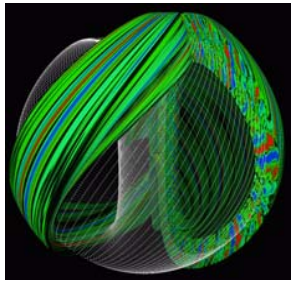
Substorm in the Magnetotail

Computation of Wave Plasma Interactions

ORNL, PPPL, MIT, Lodestar, CompX

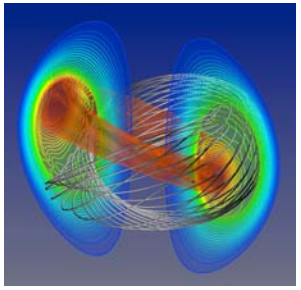


Two Pilot Projects



Plasma Microturbulence

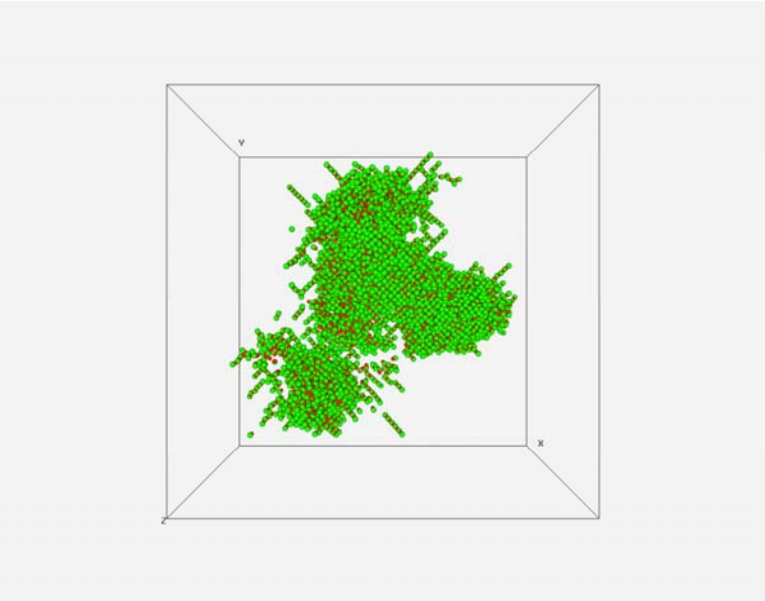
LLNL, GA, PPPL, U. Maryland, U. Texas, U. Colorado, UCLA



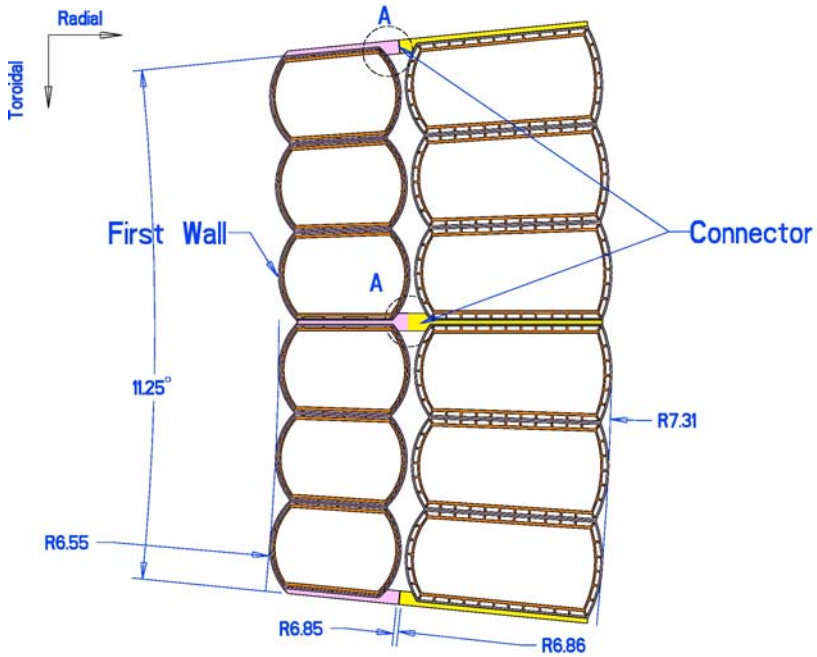
Extended MHD Modeling

PPPL, SAIC, U. Wisconsin, NYU, U. Colorado, MIT, Utah State U., GA, LANL, U. Texas

Nanoscience and New Designs are Advancing Fusion Materials and Technologies



Molecular Dynamics calculation of atomic displacements due to neutron impact.

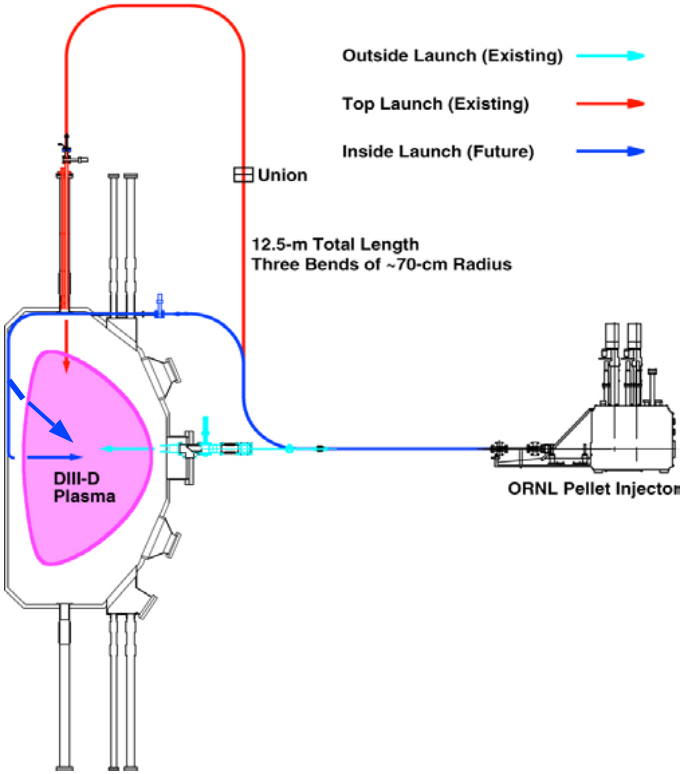


Simplified blanket designs allow high electrical efficiency and low radioactivity.

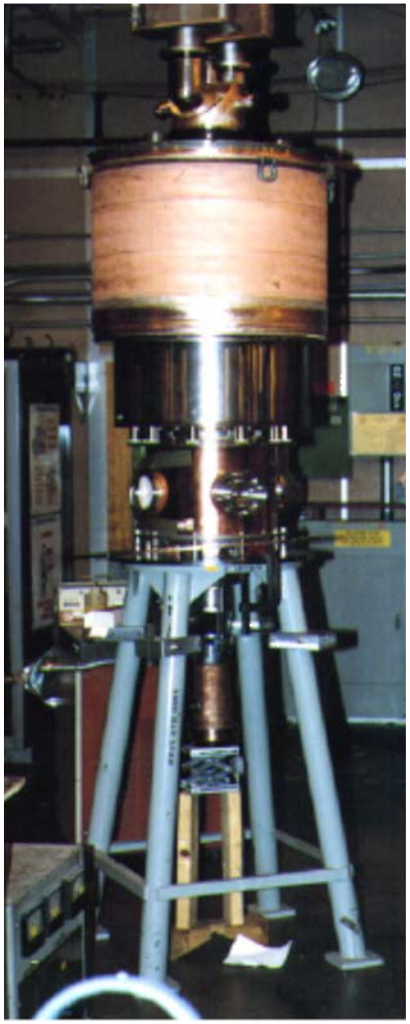
Goal: Convert fusion power to electricity with high efficiency and minimum radioactivity.

Enabling Technologies Program

Pellet Injector in DIII-D for Plasma Fueling

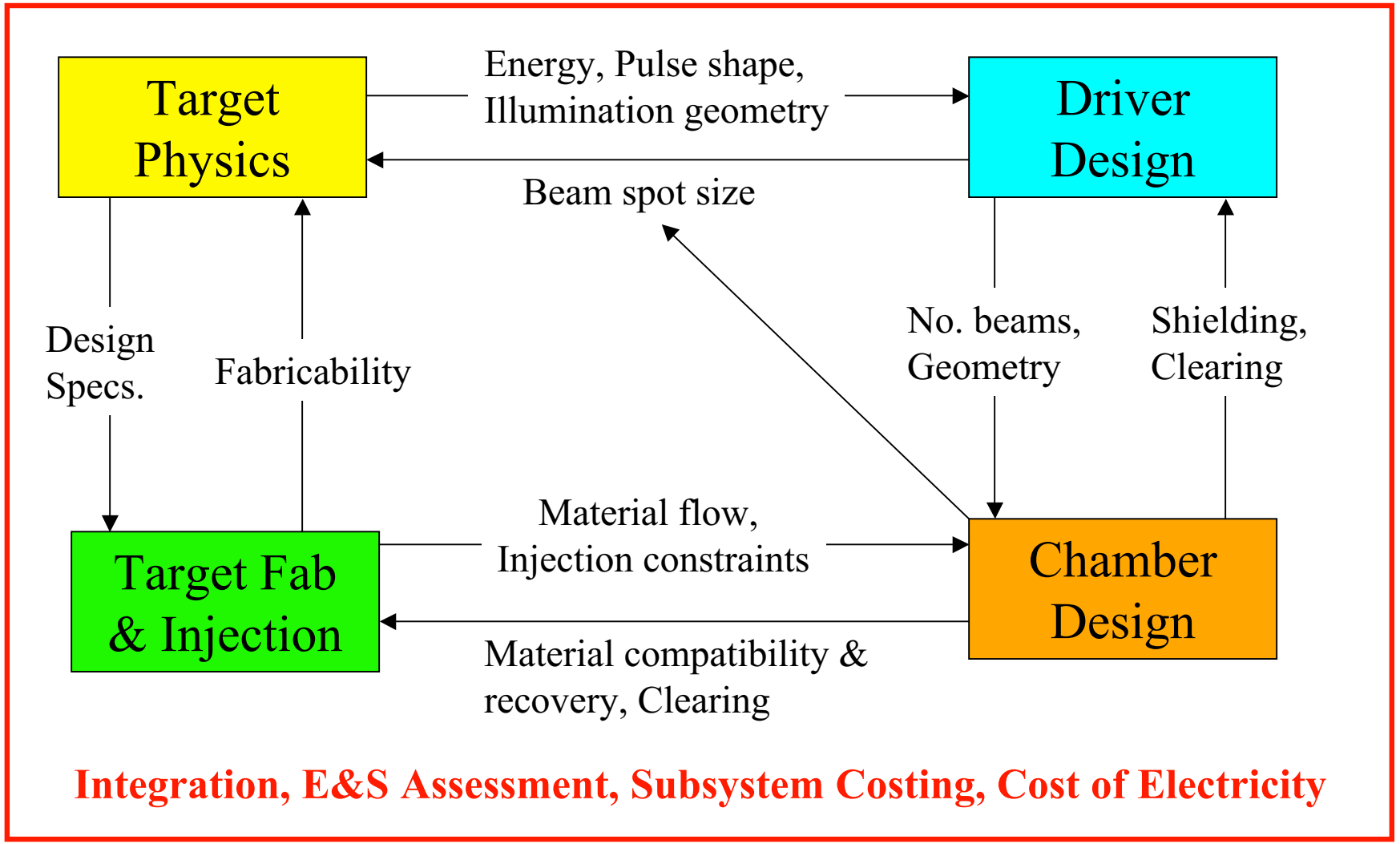


100 GHz Gyrotron Tube (1MW power in 1 second pulse) for Plasma Heating and Control



DiMES probe in DIII-D provides data on plasma material interactions

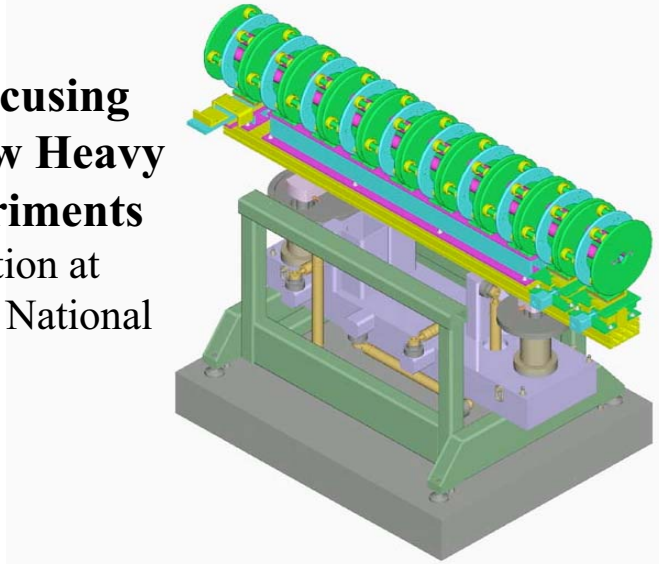
A self-consistent vision for IFE requires a balanced program to address a wide range of interconnected science and technology issues



Inertial Fusion Energy Experimental Facilities

Liquid wall chamber protection flow experiment
Georgia Tech

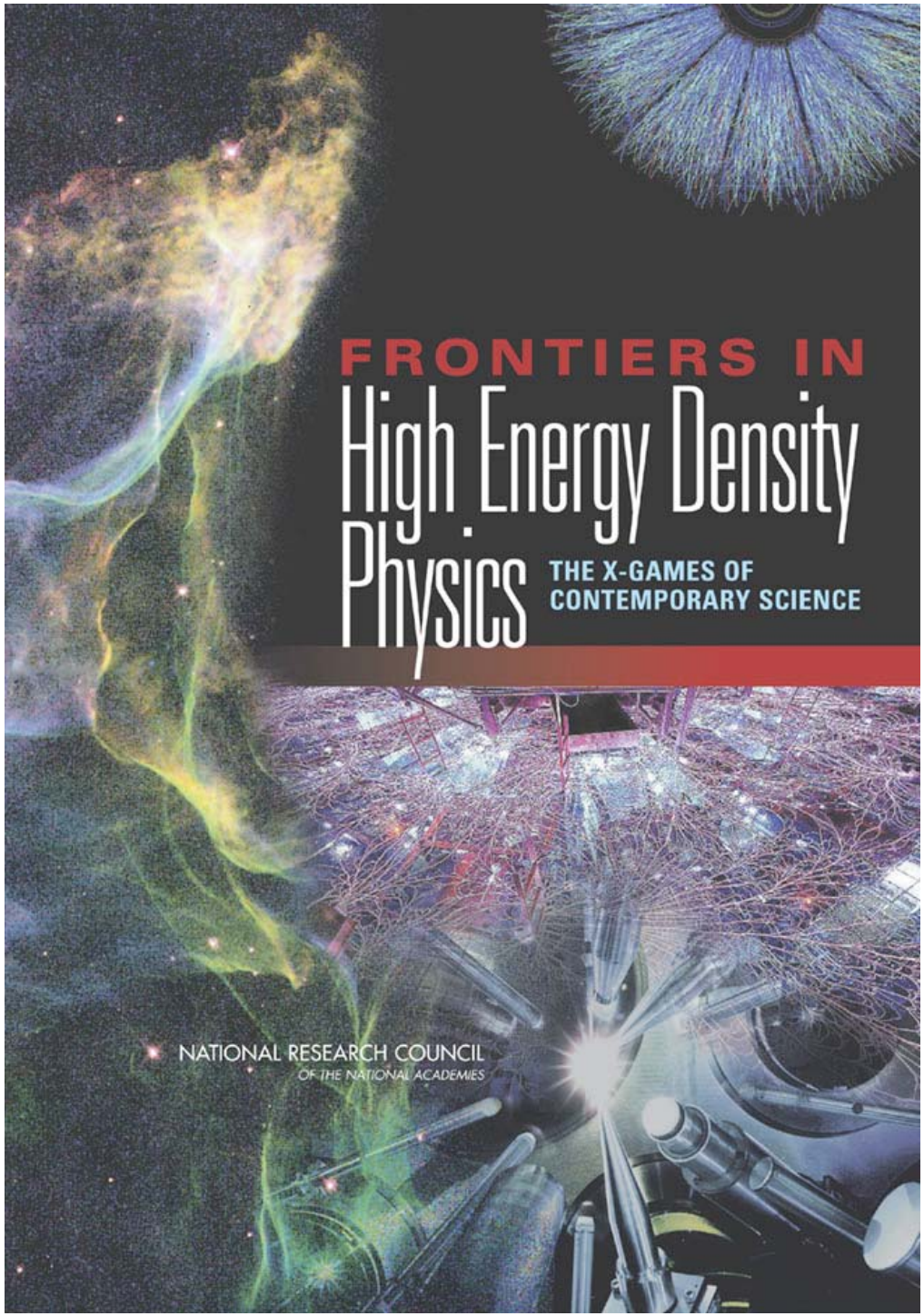
Quadrupole Focusing Assembly for New Heavy Ion Beam Experiments
(Under construction at Lawrence Berkeley National Lab)



Multi-beam Transport Experiment
Lawrence Berkeley National Lab

Frontiers in High Energy Density Physics

NRC 10/30/02



Why Basic Plasma Science

- OFES provides long term commitment to stewardship of plasma science
- Plasmas are the working medium of fusion
- Basic plasma science tackles the fundamental questions of plasma physics. Examples:
  - Waves and plasmas
  - Chaos, turbulence, and plasma structures
  - Magnetic field effects
  - Extreme states of matter
  - Non-neutral plasmas
  - Strongly coupled plasmas
- Basic plasma science problems provide attractive scientific challenges
  - Gives plasmas physics a place at the academic table
  - Promotes interest in undergraduate and graduate students
- Work force development for the future
  - Leaders in fusion power
  - Contributes to national economic well being

Research Performers and Budgets for Basic Plasma Science

- Basic Plasma Science - $4.4M
  - Includes funds for basic plasma science user facility
  - Includes $2M for FY 2003 NSF/DOE partnership announcement
- Junior Faculty Development Program - $1.3M
- Laboratory basic plasma science - $2M
- Data Centers and fundamental measurements - $1M
- Fusion Science Centers ($2M, FY 2004)
- Budgets:

FY 2003 $8.9M FY 2004 $11.1M

Planned Solicitations for FY 2003

- NSF-DOE partnership
  - ~ $4M total for 2 agencies, under review
- Junior Investigator Program
  - 1-3 to be selected, under review
- Theory Program
  - ~$4M, closing date April 15, 2003
- Experimental ICC/Alternates
  - ~$6M, University/Industry, closing date May 1, 2003
  - ~$3M, Labs, closing date May 1, 2003

Plasma Science Centers

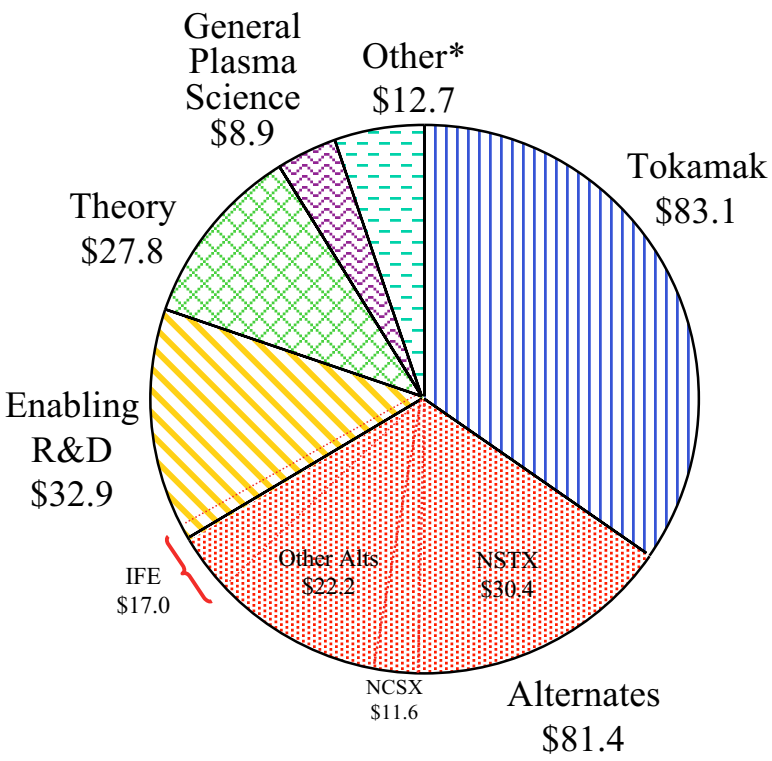
- As previously, jointly supporting with NSF
  - Basic plasma science user facility at UCLA
  - Frontier science center in plasma physics
- Ad Hoc OFES working group developing scope of announcement for FY 2004 fusion science centers competition ($2M)

Joint Support of Frontier Science Center

- One of three highly ranked proposals to NSF Frontier Science Center announcement was in plasma physics
- Research groups involved are at universities and DOE laboratories
- DOE and NSF program managers have agreed to joint funding with DOE supporting Laboratory efforts
- Presently awaiting NSF decisions about starting date for FY 2003 funding

Fusion Energy Sciences Budget

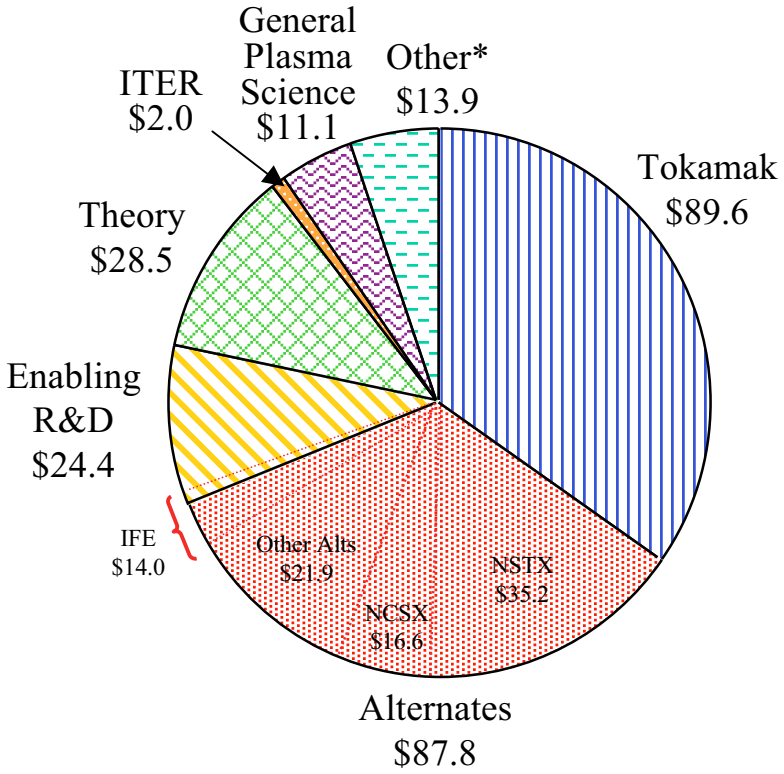
FY 2003
Appropriations



$246.9 M

* SBIR/STTR
GPP/GPE
ORNL Move

FY 2004
Congressional



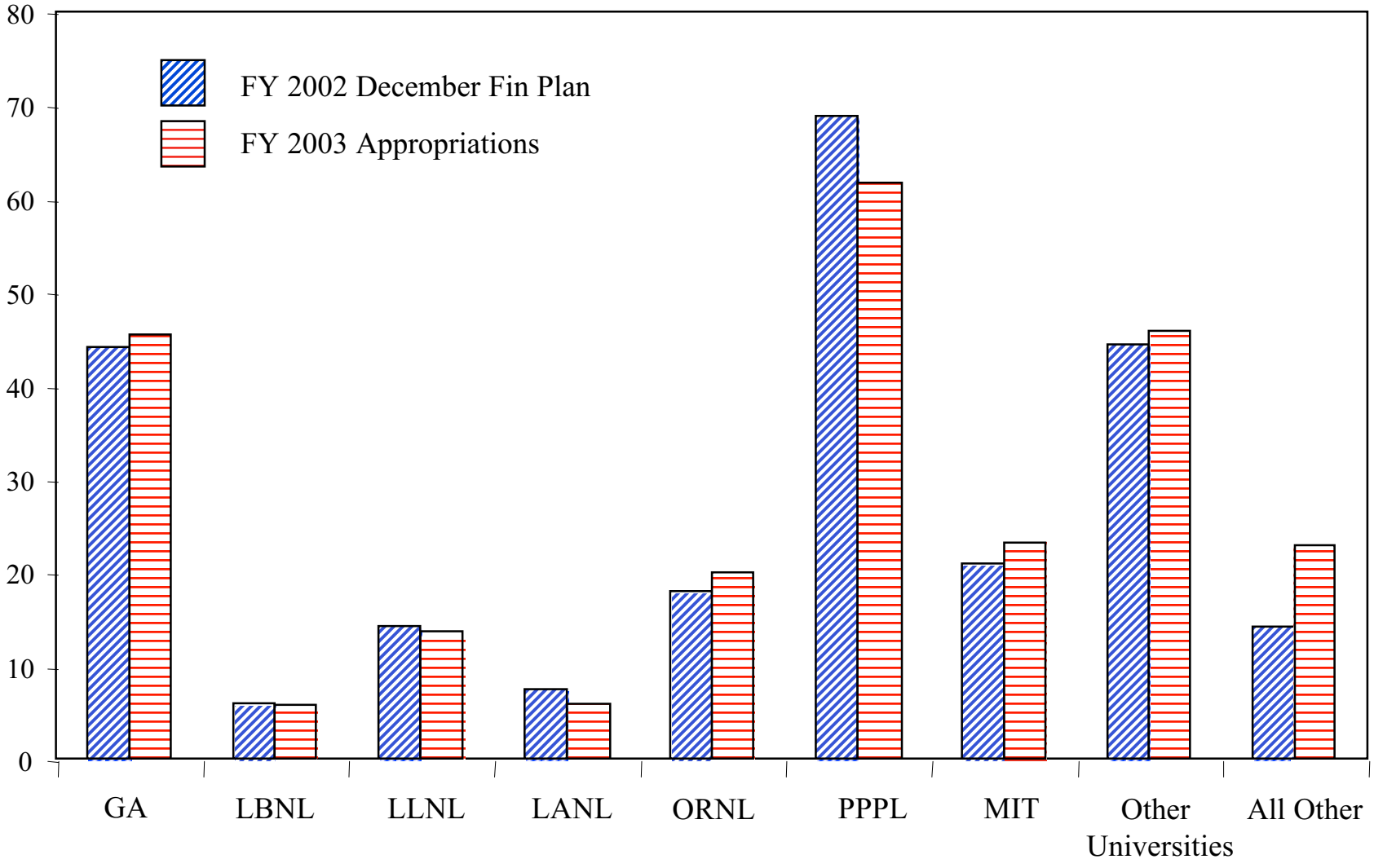
$257.3 M

* SBIR/STTR
GPP/GPE
ORNL Move
Environmental Monitoring

01/30/03

Fusion Energy Sciences Funding by Institution

($ in Millions)



04/02/03

Fusion Program Elements Addressing ITER Needs

Elements	FY 2004 Resources
DIII-D Experimental Program	$5,000,000
Alcator C-Mod Experimental Program	2,000,000
Fusion Plasma Theory and Computation (SciDAC)	3,000,000
ITER Preparations	2,000,000
Total	*$12,000,000*